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(71) Applicant (for all designated States except US): NORENT AB [SE/SE]; Box 31041, S-400 32 Göteborg (SE).

(72) Inventor; and

(75) Inventor/Applicant (for US only): APELSTRAND, Lennart [SE/SE]; Apelsingatan 41, S-421 54 Västra Frölunda (SE).

(74) Agents: ROTH, Michel et al.; Göteborgs Patentbyrå AB, Box 5005, S-402 21 Göteborg (SE).

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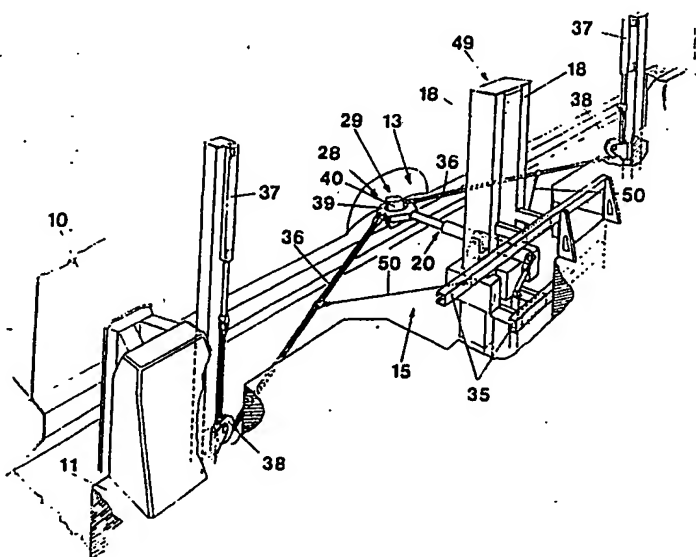
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(54) Title: MOORING SYSTEM

(57) Abstract

Mooring system between a movable unit (10), e.g. a ship and a stationary unit (11), e.g. a quay, and which system comprises partly a mooring device (15) consisting of a robot arm (20) which is movable at least in the vertical direction and provided with a coupling means (28) at one of the units (11) and partly a mooring armature (29) for receiving and fixation of the coupling means (28) at the other unit (10). The robot arm is constituted by an actuator (21) movable in the horizontal plane (Z-direction) which actuator can be activated during preferably the whole mooring phase. The coupling means (28) is connected to a device for absorbing lateral forces (transverse ship forces) acting on the free extreme end of the actuator (21), so that substantially no bending moments are transferred to the actuator (21). Said device is constituted by flexible means, arranged to act on the coupling means (28) and which are intended to transmit said forces to either unit (10 or 11) or both units (10 and 11).



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MOORING SYSTEM

The present invention refers to a mooring system between a movable unit, e.g. ship and a stationary unit, e.g. a quay, and which system comprises partly a mooring device consisting of a robot arm movable in the vertical direction which arm is provided with coupling means at one of the units and partly a mooring armature for receiving and fixation of the coupling means at the other unit.

Background of the invention

It is previously known to moore a ship at a quay by means of robot like mooring devices, whereby the maneuvering of the mooring device most conveniently takes place from the ship.

An example of such a device is shown in US 4 066 030 which refers to a mechanical connection device where a coupling bar with a coupling head at the robot is inserted in a guide formed retainer, which has a smaller slot than the width of the coupling head, and which head is turned to locking position inside the slot. The adaption to different water levels is carried out by displacing the coupling head of the robot along the slot.

If the ship moves in the lateral direction, parallel with the quay, bending moments occur in the mooring device, which it can not absorb, and which will lead to a breakdown.

Through US 4 008 678 is known a passive mooring device without active mooring force, where the ship is fixed to stationary, vertical pillars, along which the ship can move in the vertical direction. Any movement in the lateral direction is on the whole not allowed by the mooring device, why this "rigid" system is subjected to large stresses.

Through US 3 463 114 it is known to use sucking-discs for clamping of the ship relatively a quay installation and which sucking-discs are supported by an arm which is verti-

cally and laterally movable. This device demands a very large diameter of the sucking-discs, even ship sides and a high grade vacuum, which three factors not always can be guaranteed, and therefor the system is very unsafe.

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Through the british patent 2.080.228 is known a so called "link span anchorage" and which is intended by means of arms keep a stationary pontoon along a quay independent of variations in the water level. In a similar way as according to the publications stated above, the coupling device, which is firmly connected to the kevel head, is vertically movable by means of a slider, which is movable along vertical pillars. This device is not a temporary mooring device, but a permanent holding device. The pontoon is resiliently moored to the quay by means of wires, but these moorings cannot absorb the lateral forces which may occur at the free extreme ends of the arms.

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Common to these prior mooring or retaining devices is that all technical problems have not been solved which are related to mooring devices of this type, despite for a long time existing need.

The object of the invention and most essential features

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The object of the present invention is to provide an active mooring device, which is structurally simple, which in principle consists of only one actuator, e.g. a hydraulic cylinder, which gives a possibility of a relatively long retracting distance. Further it has to be designed such that no bending moments are transmitted to the actuating device, on the ship side it should have a very small installation depth and there should be a possibility for mounting externally along the ship fender ledge. The device further should be designed such that it does not demand any greater precision at the landing and in passive position it should be protected inside the ship fender line of the quay.

These tasks have been solved by the robot arm being constituted by a actuating device, which is movable in the horizontal direction (z-direction), preferably actuatable during the whole mooring phase, and that a device is connected to the coupling means, for absorbing of lateral forces acting on the extreme free end of the actuating device (lateral ship forces), so that substantially no bending moments are transmitted to the actuating device, and that said device is constituted by bendable means, provided to act on the coupling means and which are intended to transmit said forces to either of the units or to both of the units.

Description of the drawings

The invention will be described in closer detail below in some embodiments with reference to accompanying drawings.

Fig.1 shows in a diagrammatical view from the above of a ferry which has landed at a quay and is moored by means of the devices according to the present invention.

Fig. 2a-2g shows in seven lateral views maneuvering sequences at mooring of a ship, whereby fig. 2a shows the mooring device in a protected position inside the ship fender line, fig. 2b during adjustment of the vertical position relative to the ship, respectively the water surface, fig. 2c shows the device during pushing out of the mooring cylinder, fig. 2d pivoting out of the mooring cylinder, fig. 2e position finding of the mooring armature at the ship, fig. 2f hauling of the ship by means of the mooring cylinder and fig. 2g the ship in mooring position.

Fig. 3 shows in larger scale a first variant in a view from the front of a mooring device according to the invention.

Fig. 4 shows a section along the line IV-IV in fig. 3.

Fig. 5 shows a lateral view of the mooring device illustrated in fig. 3.

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Fig. 6 is a section along the line VI-VI in fig. 4.

Fig. 7 shows the mooring armature illustrated in fig. 4 in a view from the front and partly in section.

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Fig. 8 shows a section along the line VIII-VIII in fig. 7.

Fig. 9 shows in perspective view a second embodiment of the mooring device according to the invention.

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Fig. 10 shows the mooring device according to fig. 9 in a view from the front.

Fig. 11 is a section along the line XI-XI in fig. 10.

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Fig. 12 is a section along the line XII-XII in fig. 10.

Fig. 13 shows a section along the the line XIII-XIII in fig. 12.

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Fig. 14 shows a view from the above of the mooring armature and the coupling means illustrated in fig. 13.

Description of embodiments

30 In fig. 1 is shown an embodiment of how the mooring device according to the invention can be used for mooring of two units 10,11, of which one can be a ship, a ferry, a barge or some other floating object, while the other unit can be constituted by a quay, kevel head, an oil-rig or the like, that is a stationary plant. In the example shown in fig. 1,
35 which shows a railway ferry, has been used a type of mooring device 12 at the bow, which is exposed only to small angular deviations and a mooring device 13 with a spring function at

the stern of the ship. The ship - the railway ferry - , is equipped with a movably mounted ferry flap 14 , which locks the ship at the quay in such a way, that it also absorbs longitudinal ship forces. In this case thus only one mooring
5 device 12 is required at the bow, which absorbes cross ship forces and smaller deviations from these, and a mooring device 13, which also can absorb longitudinal ship forces..

The embodiment shown in figures 3-6 consists of a mooring
10 device 15 provided at the stationary unit, that is the quay 11, and which comprises a fixed stand 16 in the form of a frame 17, the vertical frame sides of which form a guide 18 for a robot slider 19. This supports a robot arm 20, which in the embodiment shown is constituted by an actuator 21,
15 e.g. a hydraulic cylinder, which is pivotably arranged on bearings such that it has at least two, at least three degrees of freedom, that is a large mobility in the vertical plane - the Y-axis -, limited mobility in the vertical plane -X-axis, and the movable part of the actuator- the piston
20 rod- is movable in the Z -axis.

The robot slider 19 which supports the robot arm 20, is by way of a wire, cable or chain arrangement 22 and pulleys 23 counter balanced by means of weights 24. By means of a
25 driving device 25, fig. 6 which acts on one of the pairs of pulleys 23, the elevation of the slider 19 can be changed. The robot arm is pivotable about its horizontal axis 26 by means of a second actuator 27, which as well can be a hydraulic piston cylinder.

30 At the extreme free end of the robot arm 20 is provided a coupling means 28 formed as a hook with a relatively large curved contact surface for a mooring armature 29 arranged at the second unit 10- the ship. In this embodiment this is
35 constituted by a bendable means 30, e.g. a wire, which at its both ends is connected to at least one tension spring 31, the opposite end of which is connected to the unit 10.

The connection means between the bendable means 30 and the tension springs 31 are formed with a guide 33, which cooperates with a slot 34, which limits the extension length of the tension spring. In a non actuated position the bendable means 30 takes a straight position, protected by the ship fender line or shell plating, so that the hook-formed coupling means 28 can grip behind the wire, such as is shown in fig. 4.

In the figures 2a to 2g is shown diagrammatically a maneuvering sequence of how a mooring with the device according to the invention may be carried out. Figure 2a shows the mooring device with the robot arm folded up to a protected position inside the outer edge of the quay, which normally is a fender arrangement not shown. When the ship approaches the quay 11 the mooring device 15 is manipulated by means of radio signals whereby as a first measure an adjustment is carried out of the elevation of the robot arm. This elevation adjustment can be performed either against one or several direction marks at the shell plate of the ship or with reference to the present water surface. This sequence is shown in fig. 2b. Thereafter the piston bar of the robot arm 20 is pushed out, such as is shown in fig. 2c simultaneously as the robot arm is turned to stand by position, fig. 2d and 2e while awaiting the ship coming so close that an interconnection of the coupling means 28 of the robot arm and the mooring armature 29 of the ship can be carried out. When the interconnection is carried out, that is the hook formed coupling means has gripped behind the wire 30, the hauling in of the ship against the quay can be carried out such as shown in fig. 2f and 2g.

If another ship passes outside the moored ship, forces will occur, which tend to move the moored ship along the quay, and forces which will pull the ship from the quay. It is known that the forces increase if the speed of the ship increases. Therefor, the cylinders of the robot arms prefe-

ably during the whole mooring phase have a constant holding pressure and resiliently absorb the forces transverse of the centerline of the ship. Since the coupling means 28 can be moved somewhat along the wire 30, also small angular deviations in the horizontal plane can be allowed, that is, to a smaller extent the robot arm also can absorb longitudinal ship forces, which are transmitted by means of the springs 31 to the hull of the vessel.

10 A second embodiment of the invention is shown in fig. 9, which in many parts are similar to the embodiment according to figures 3-8 and for those parts which are alike in both embodiments the same reference designations also have been used. What differs both embodiments is the mooring device
15 according to fig. 9 being completed with a spring function and that the robot arm 20 is movable in the horizontal plane. For this purpose are provided linear guides 35 at the stationary unit 11, along which guides a slider 49 is displaceable.

20 The spring function of the mooring device is provided by stays 36 directed in opposite directions and articulatedly joined to the coupling means 28 of the robot arm 20, which stays at their opposite ends are connected each to a hydraulic power apparatus 37 by a pulley 38. The cylinders of the
25 robot arms are dimensioned to absorb the forces transverse of the centerline of the ship and the spring absorbs the longitudinal and the cross ship forces.

30 The mooring armature 29 on the movable unit 10 in fig. 9 is constituted by a keel head 40 and the coupling means 28 of the robot arm 20 thus is formed as a ring 39, which can be thread over the keel head 40. The hydraulic power apparatuses 37 can also be used to position the robot arm before a
35 mooring, whereby the robot slider 19 is vertically displaceable along a guide 18 contained in a slider 49, which in turn is movable along guides 35 fixedly mounted at the quay

11.

5 The horizontal displacement of the slider 49 along the guides 35 is carried out by means of the power apparatuses 37, whereby between the stays 36 and the robot slider 19 are provided interconnection links 50, which transmit the tensile forces to the slider 49.

10 The embodiment according to figures 10 - 14 in essential parts is similar to the embodiment shown in fig. 9. What distinguishes is primarily the design of the mooring armature at the movable unit 10, which in principle is Y-formed and where the diverging shanks 42 form guide surfaces, to guide the head 43 of the coupling means 28 to correct mooring position. In this way the positioning of the ship
15 relatively the robot arm has not to be so precise, as is the case with the ring shaped coupling means 28 according to fig. 9. In order to get the fixing point of the stays 36 to be positioned at the center of the head 43, the stays are
20 fixed to angular arms 44, which have their common rotation center 45 at the center of the head 43.

What further distinguishes the embodiment according to figures 10 - 14 from the embodiment according to fig. 9 is that
25 the guides 35, which guide the stand 16 at horizontal displacement, are contained in a stationary frame 46, which is firmly connected to the quay 11. By way of an arrangement of wires 47 and pulleys 48 the movable stand 16 is guided in the lateral direction.

30

The invention is not limited to the embodiments shown and described but a number of variants are possible within the scope of the patent claims. In the embodiments described the unit 10 has been stated to be the movable unit, that is a
35 ship, a ferry a barge or the like, while the stationary unit can be a quay, an oil-rig or the like, but of course it is possible to place the mooring device on the movable unit and

the mooring armature on the stationary device.

CLAIMS

1. Mooring system between a movable unit (10), e.g. a ship
and a stationary unit (11), e.g. a quay, and which system
comprises partly a mooring device (15) consisting of a robot
arm (20) which is movable at least in the vertical direction
(Y-direction) and provided with a coupling means (28) at one
of the units (11) and partly a mooring armature (29) for
receiving and fixation of the coupling means (28) at the
other unit (10),
characterized therein,
that the robot arm is constituted by an actuator (21)
movable in the horizontal plane (Z-direction) which actuator
can be activated during preferably the whole mooring phase,
that the coupling means (28) is connected to a device for
absorbing lateral forces (transverse ship forces) acting on
the free extreme end of the actuator (21), so that substan-
tially no bending moments are transferred to the actuator
(21), and that said device is constituted by flexible means,
arranged to act on the coupling means (28) and which are
intended to transmit said forces to either unit (10 or 11)
or both units (10 and 11).
2. Mooring system according to patent claim 1,
characterized therein,
that the flexible means (30,36) are provided between the
coupling means (28) and the unit (11) at which the robot arm
(20) is provided.
3. Mooring system according to patent claim 1,
characterized therein,
that the mooring armature (29) is constituted by a flexible
means, e.g. a wire (30) which is spring loaded at least at
one end, and that the coupling means (28) is hook formed and
provided with a curved contact surface for the wire (30), so
that at laterally directed load the coupling means (28) is
movable along the wire.

4. Mooring system according to fig. 3,
c h a r a c t e r i z e d t h e r e i n,
that the end of the wire (30) connected to the spring (31)
respectively the ends is (are) forcibly guided in a groove
5 (34).

5. Mooring system accoprding to fig. 1,
c h a r a c t e r i z e d t h e r e i n,
that the coupling means is pivotably mounted in opposite
direction laterally directed stays (36), which are intended
10 to absorb the spring forces of the movable unit.

6. Mooring system according to fig. 5,
c h a r a c t e r i z e d t h e r e i n,
that the ends of the stays (36) turned away from the coup-
15 ling means (28) are connected each to a power apparatus
(37). e.g. a hydraulic means and that the actuator is pro-
vided in a slider (49), which is movable along a longitudi-
nal guide (35) by means of said power apparatus.

20 7. Mooring system according to patent claim 1 or 6,
c h a r a c t e r i z e d t h e r e i n,
that the robot arm (20,21) by means of a driving device (25)
is movable in the vertical direction along guides (35) in
the slider (49) respectively a fixedly arranged stand (46)
25 at one of the units (10,11).

8. Mooring system according to patent claim 5,
c h a r a c t e r i z e d t h e r e i n,
that the coupling means (28) at the free end of the actuator
30 (21) is formed as a head (43) intended to cooperate with a
mooring armature (27) developed with a complementary form,
and that the laterally directed stays (36) are pivotally
mounted to the head (43).

35 9. Mooring system according to patent claim 6,
c h a r a c t e r i z e d t h e r e i n,
that between respective stay (36) and the slider (49) is

provided an interconnection link (50), for transmission of traction forces at displacement of the slider (49) by means of respective power apparatus (37).

- 5 10. Mooring system according to any or some of previous patent claims,
c h a r a c t e r i z e d t h e r e i n,
that the actuator (21, 27) of the robot arm and/or the power
10 apparatus (37) of the stays (36) are connected to a hydraulic system, which is active during the mooring phase and in which system is contained a control system, which is provided to adapt the power in the apparatuses (21, 27, 37) to the present load to which these are exposed.

FIG. 1

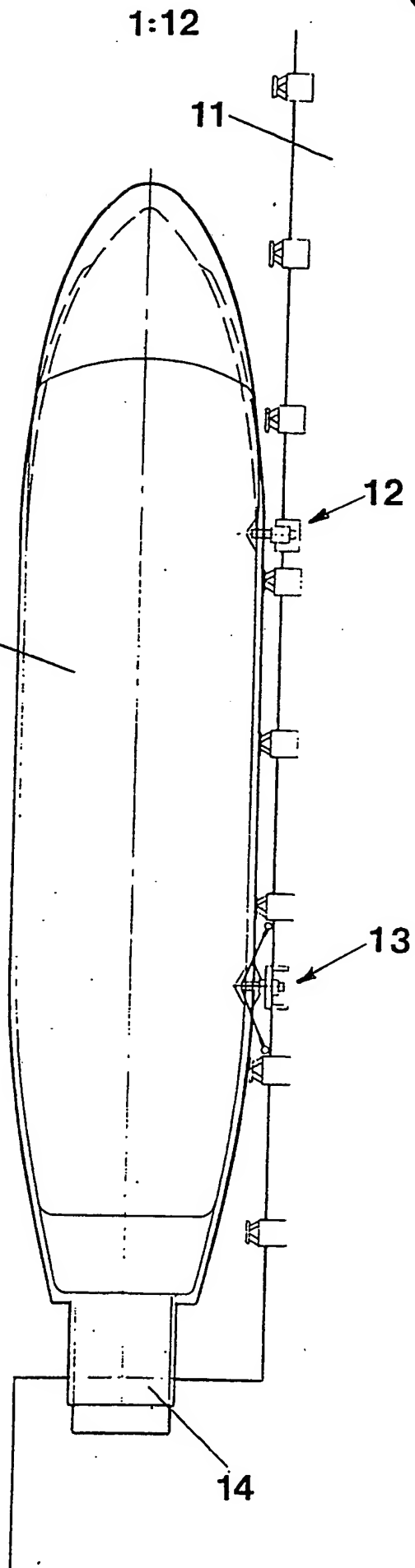


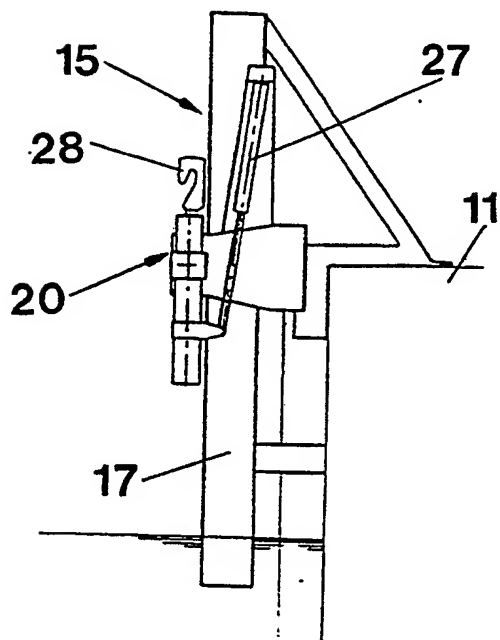
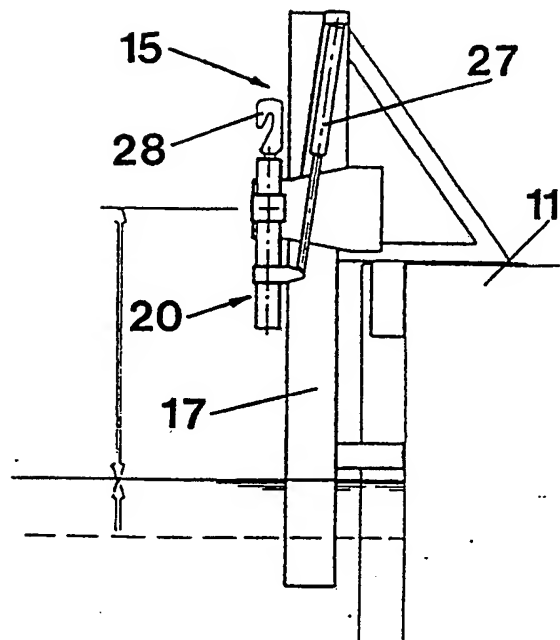
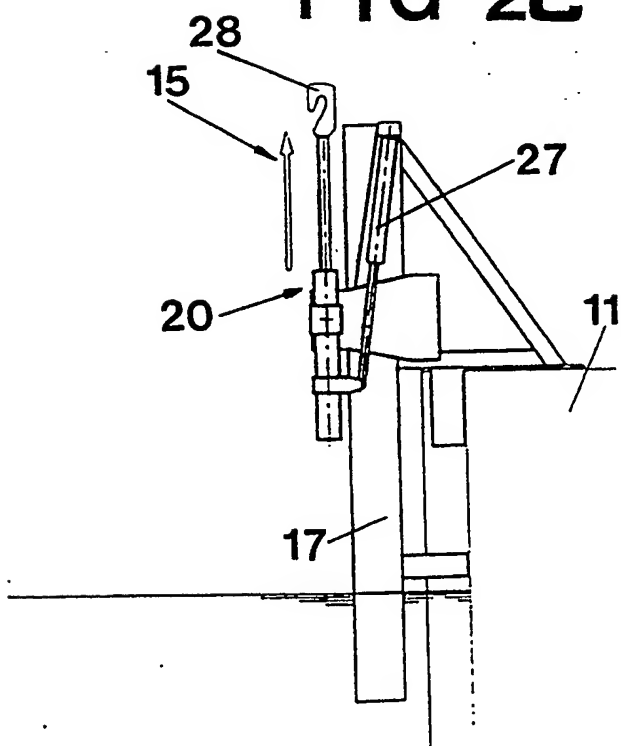
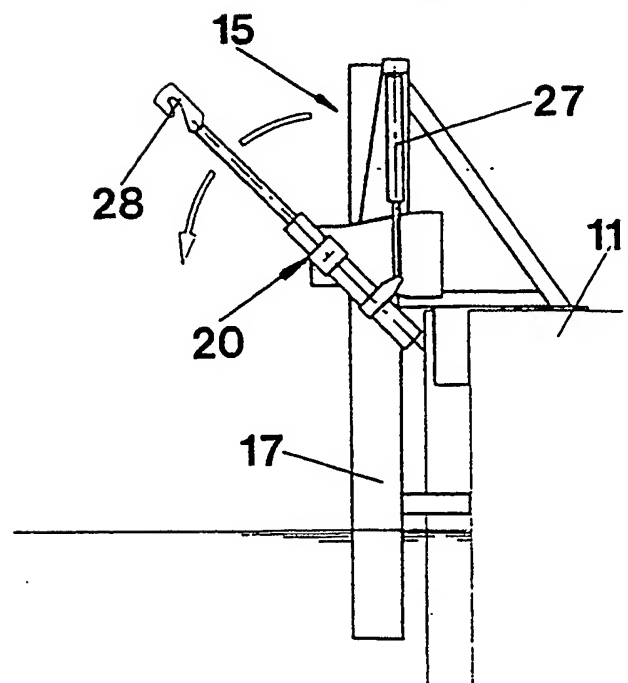
FIG 2A**FIG 2B****FIG 2C****FIG 2D**

FIG. 2E

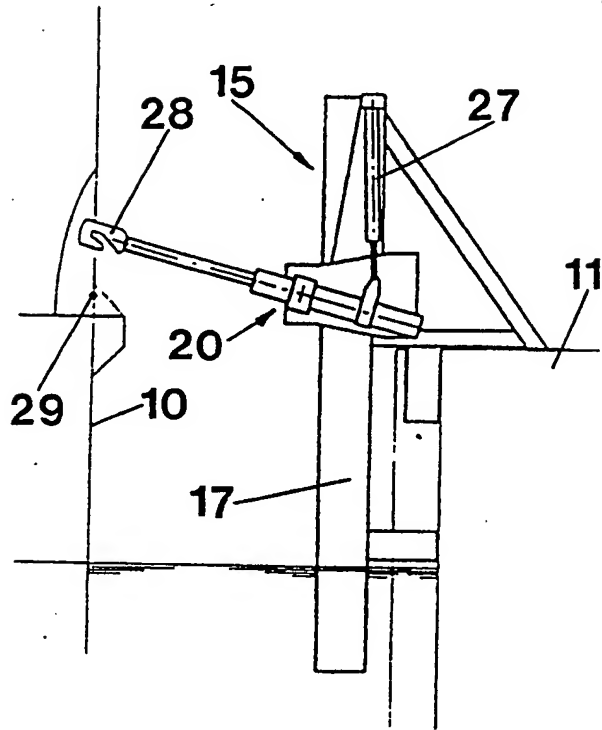


FIG. 2F

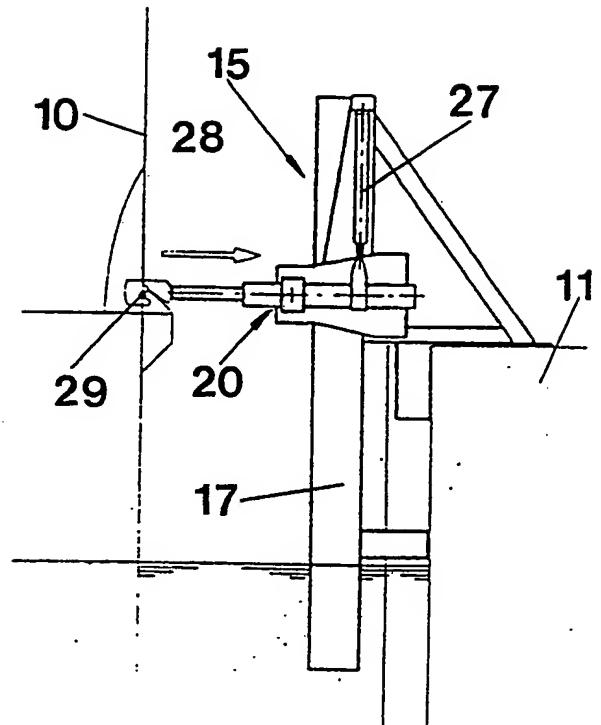


FIG. 2G

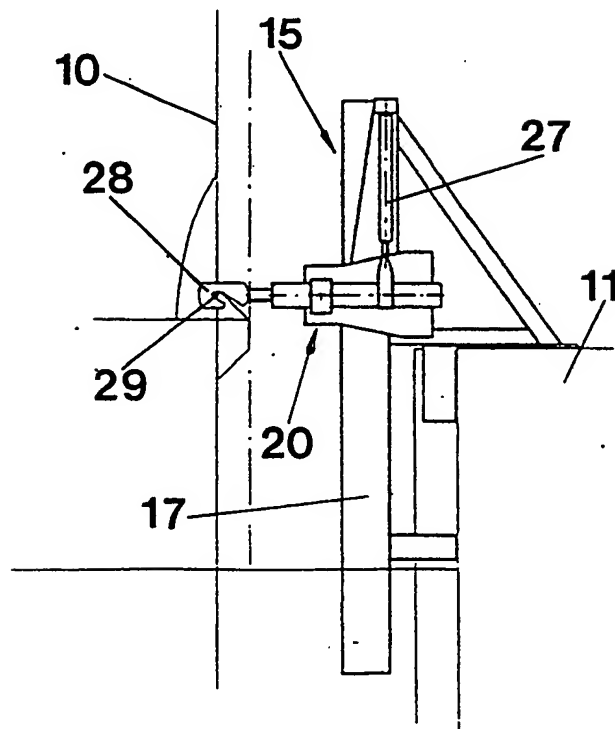


FIG. 5

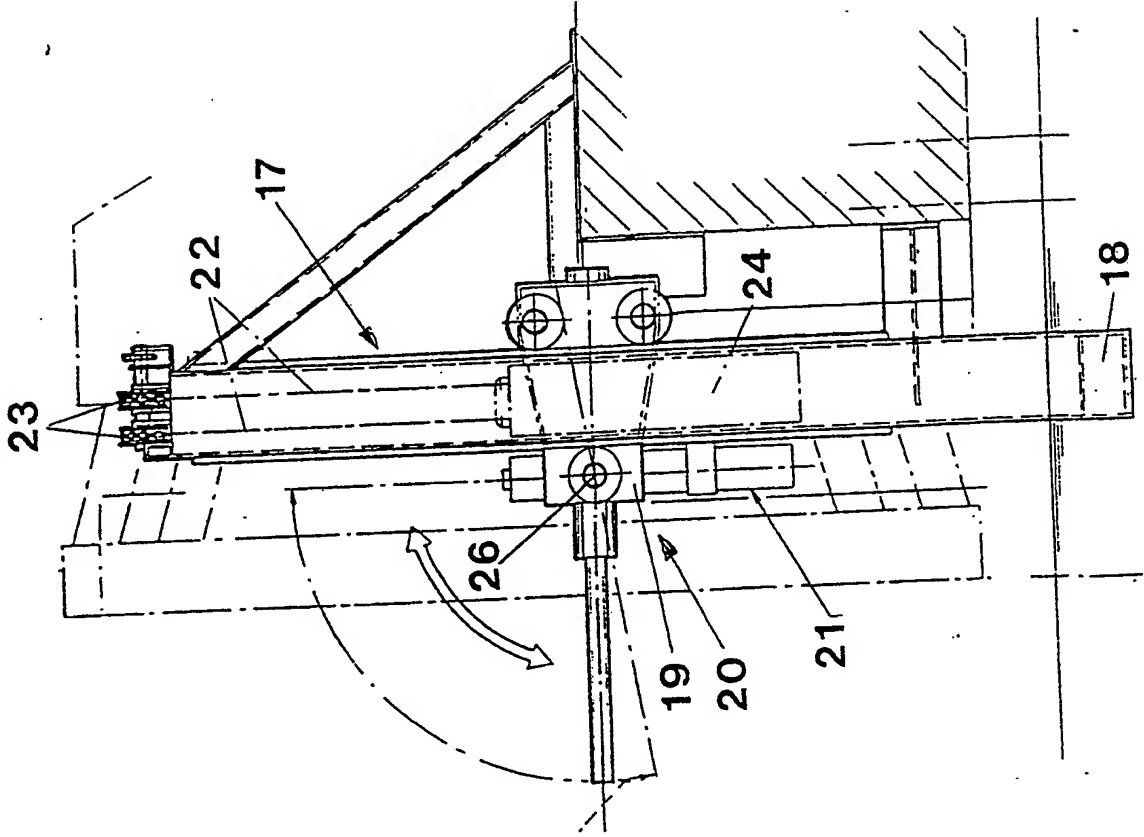


FIG. 3

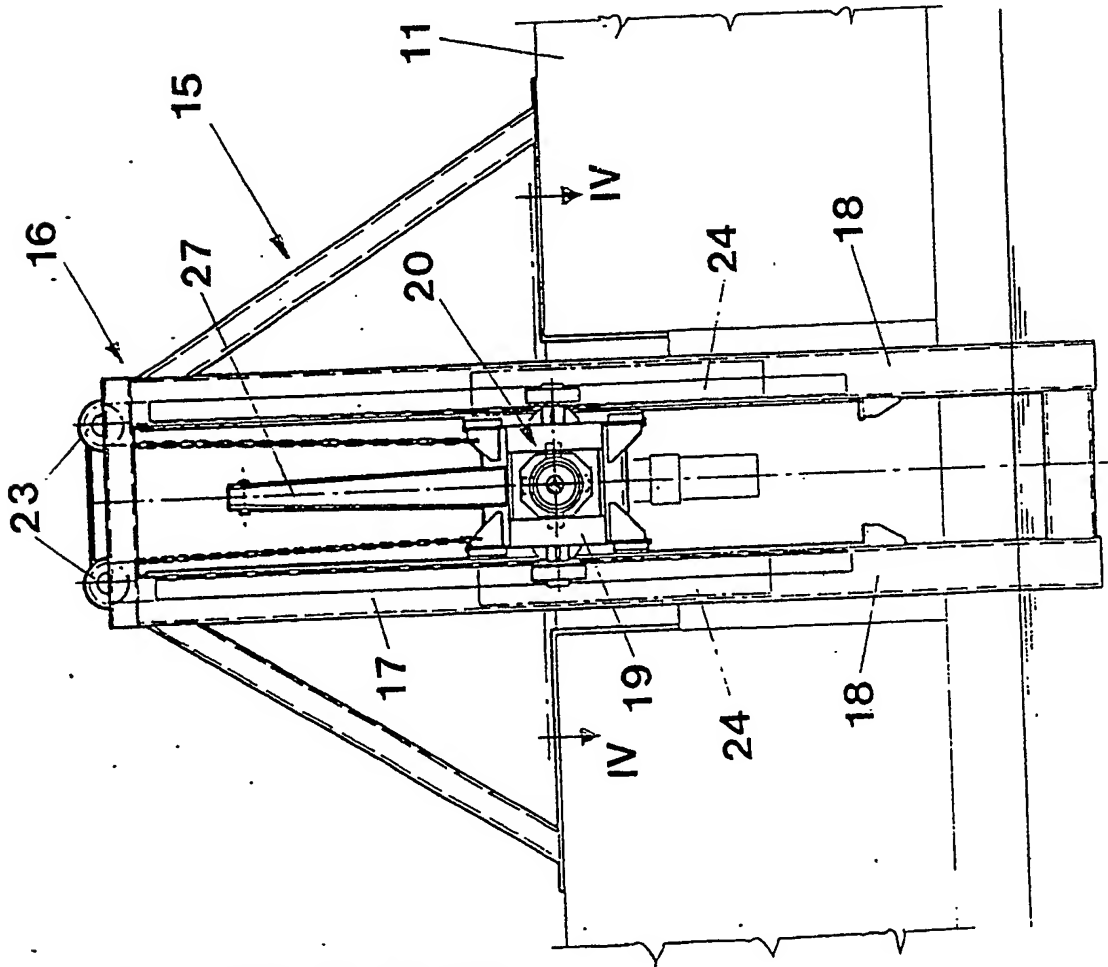


FIG. 4

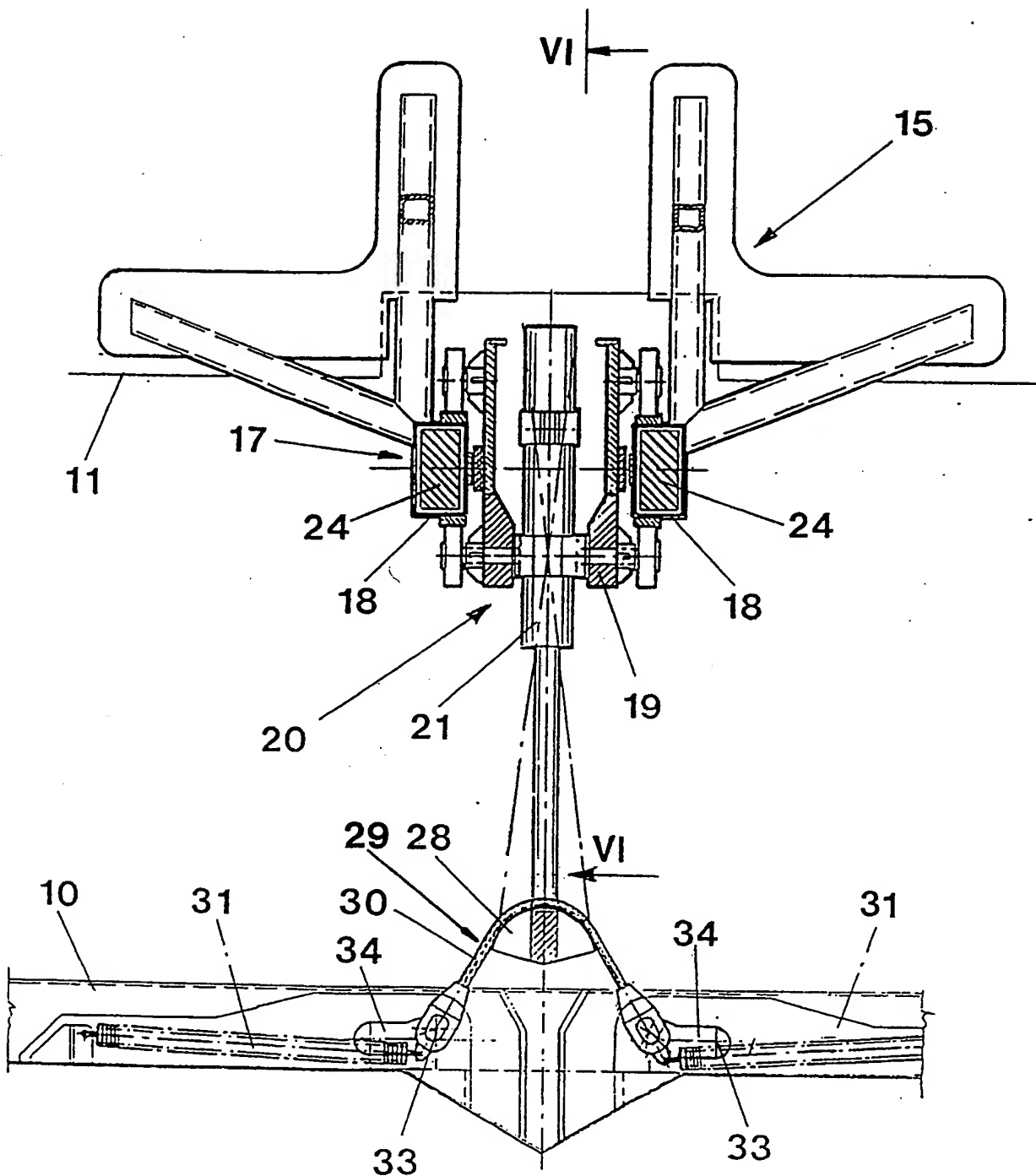
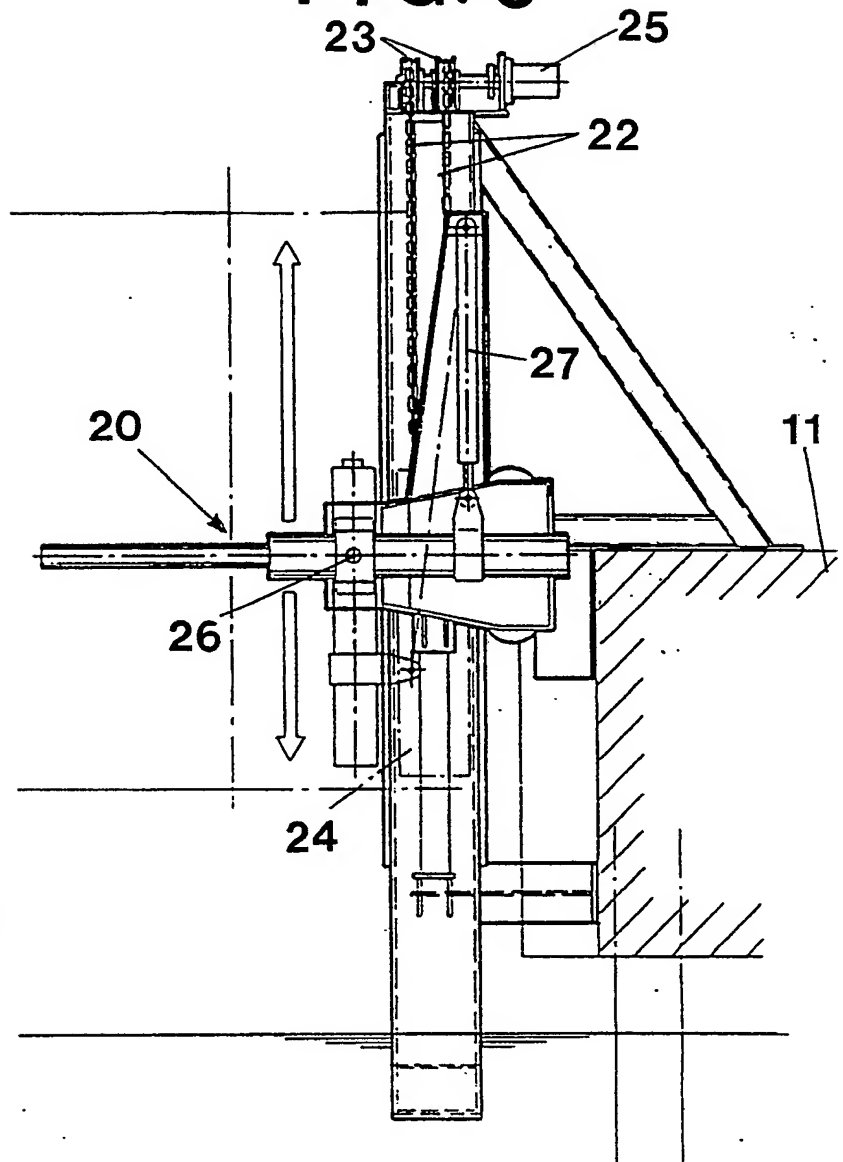
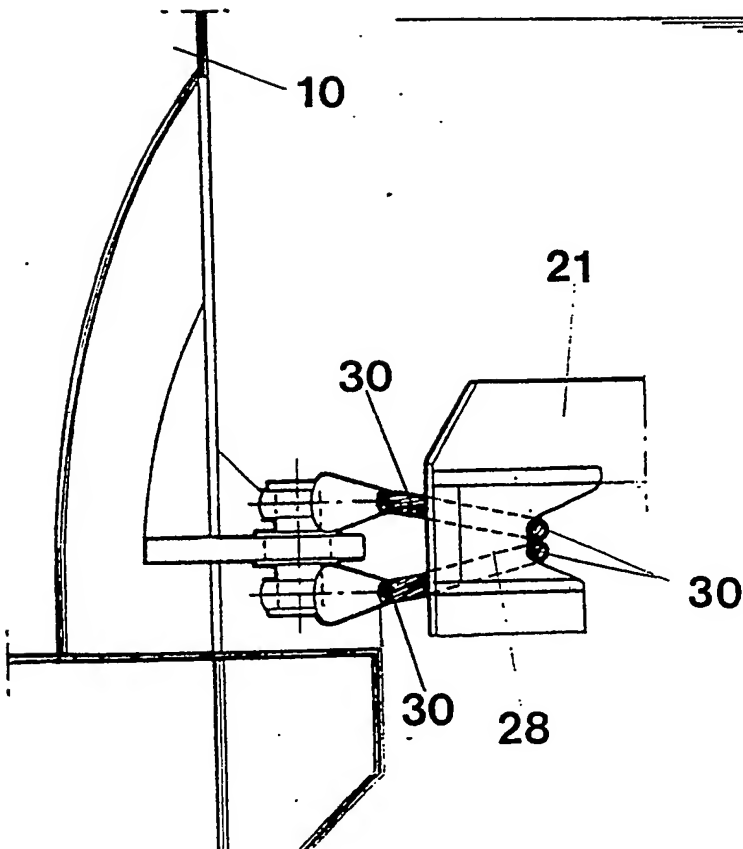
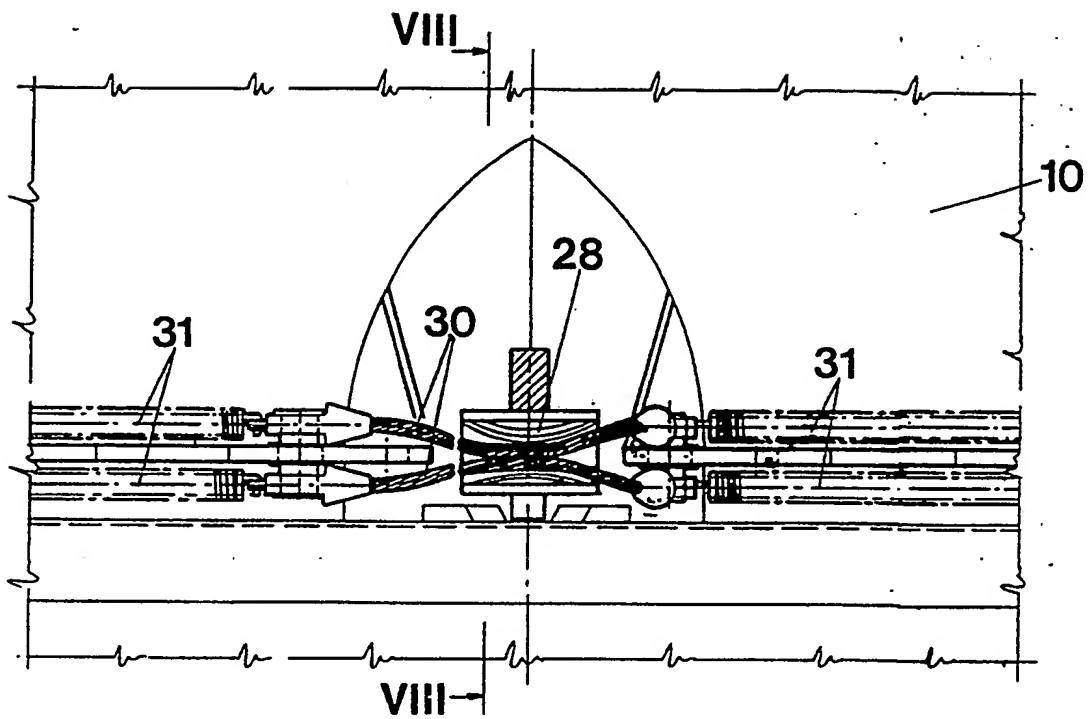


FIG. 6**FIG. 8**

7:12
FIG. 7



8:12

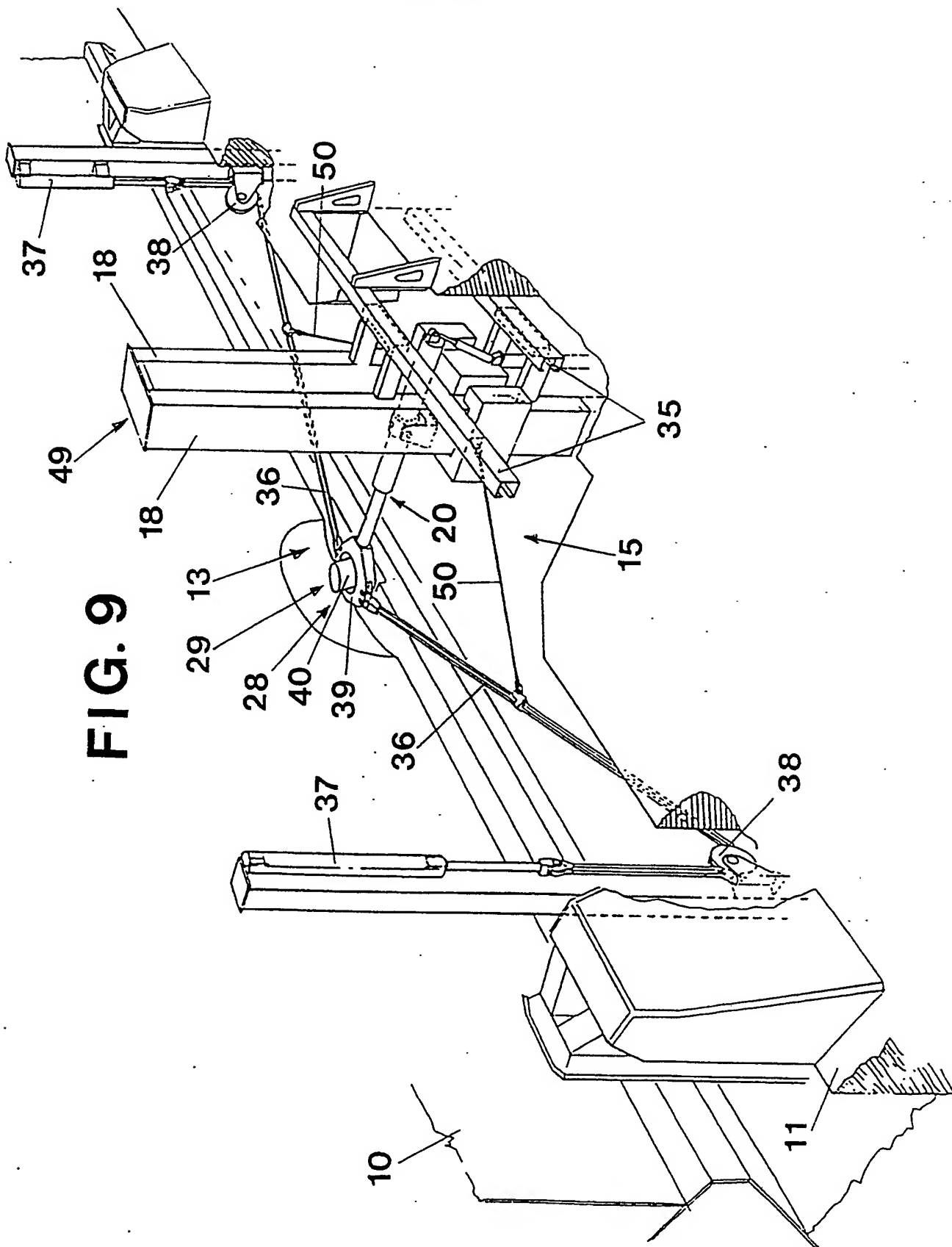


FIG. 10

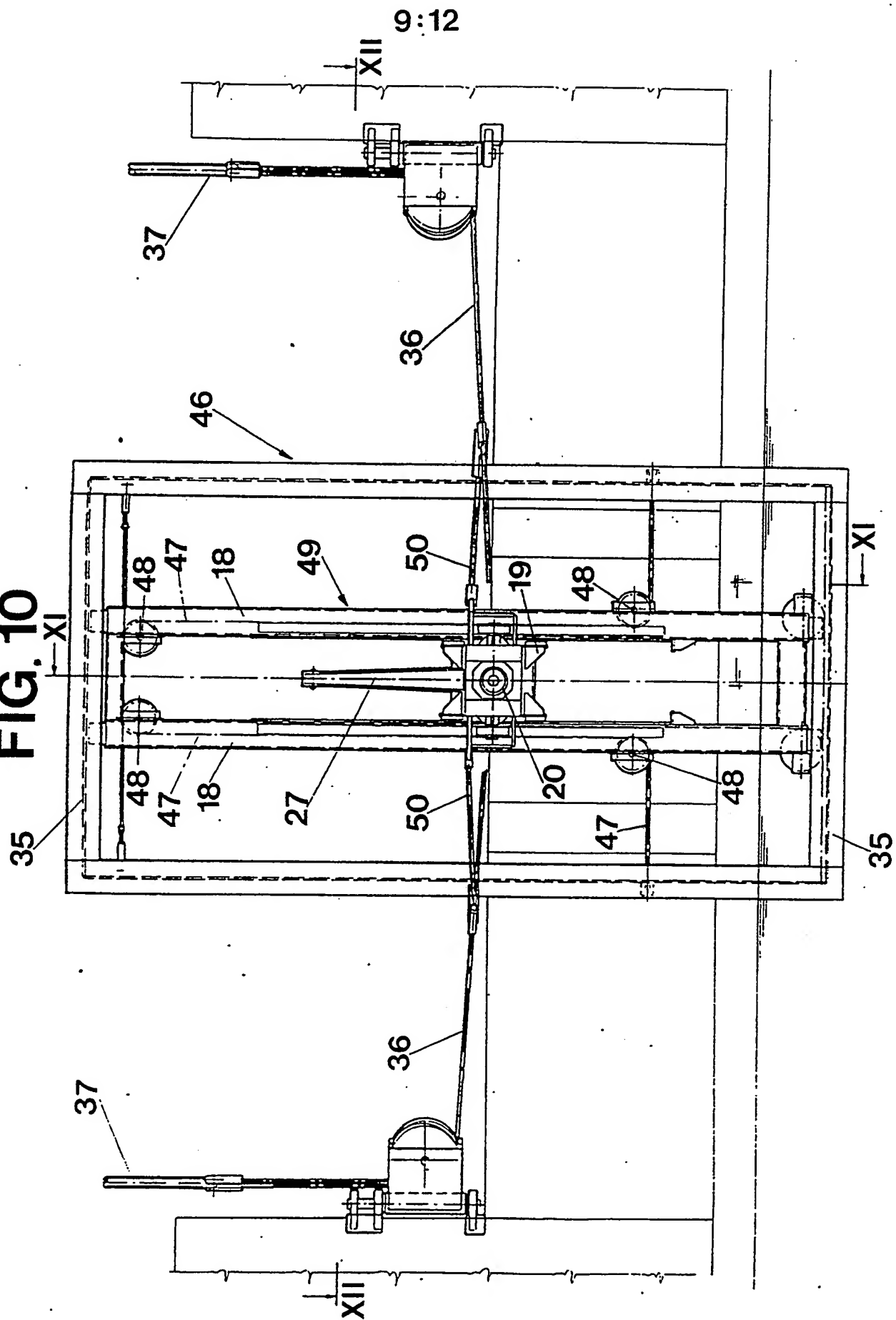


FIG. 11

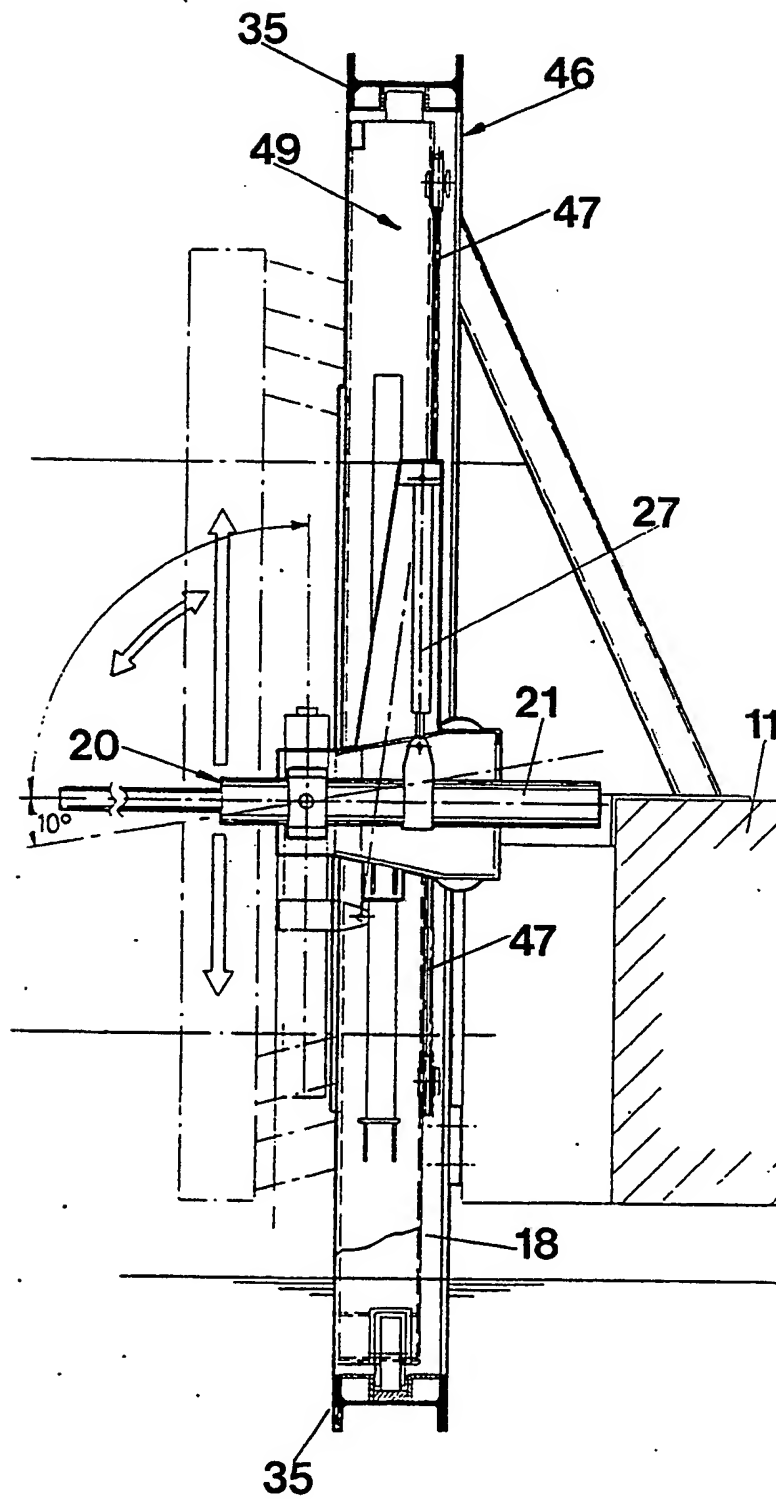
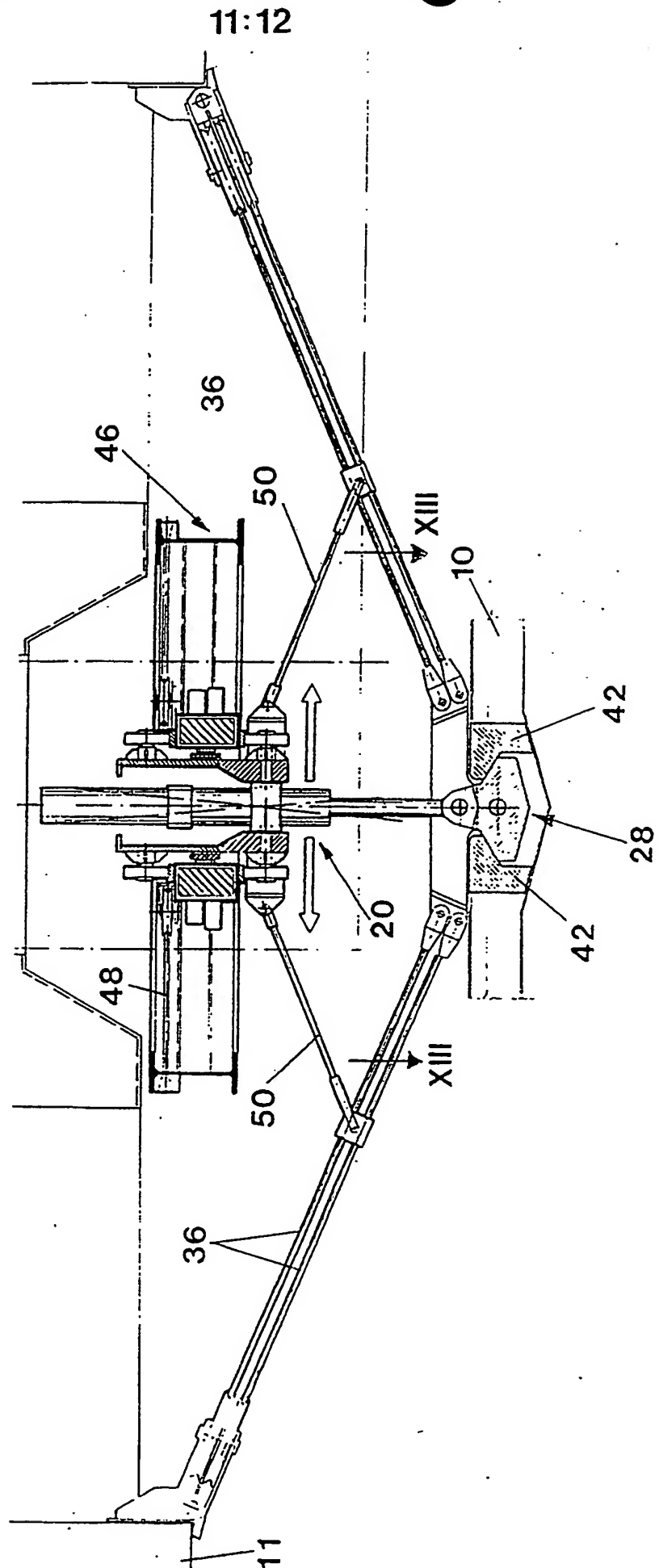


FIG.12



12:12

FIG. 13

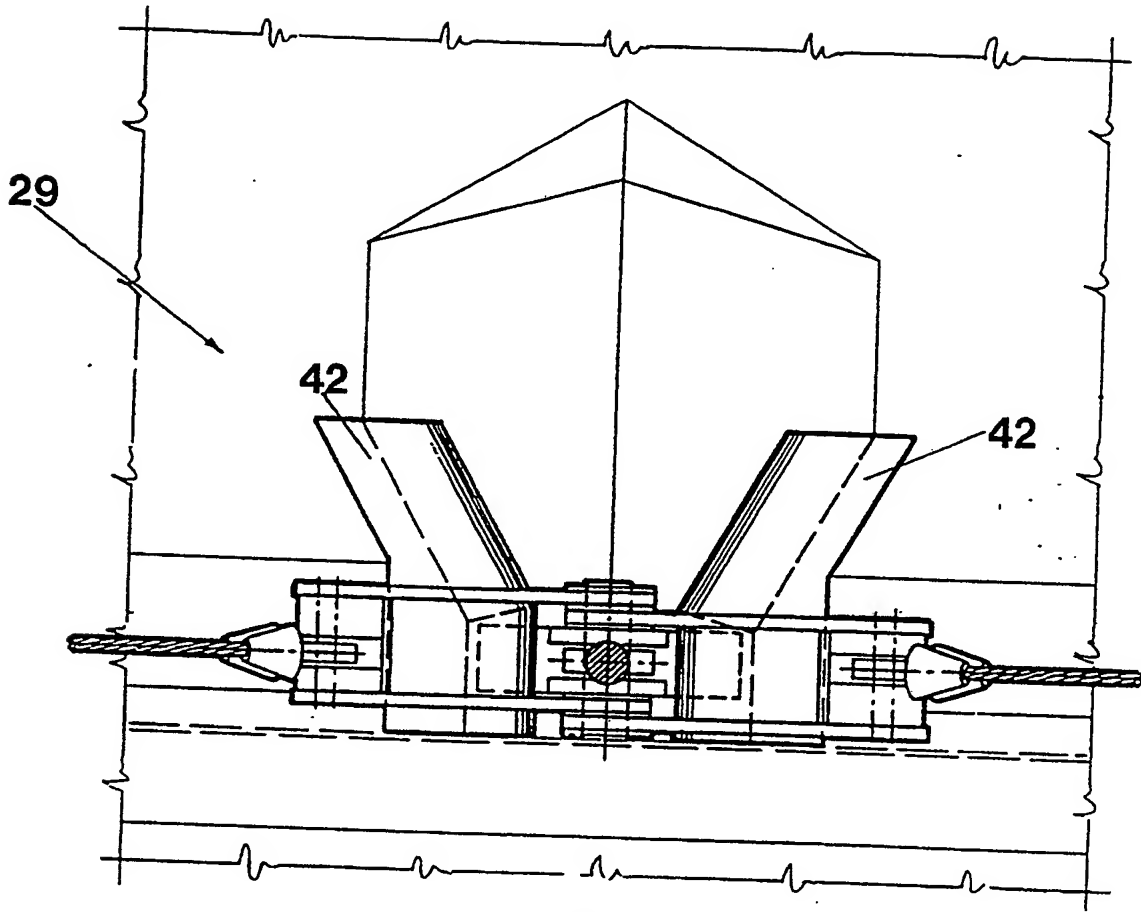
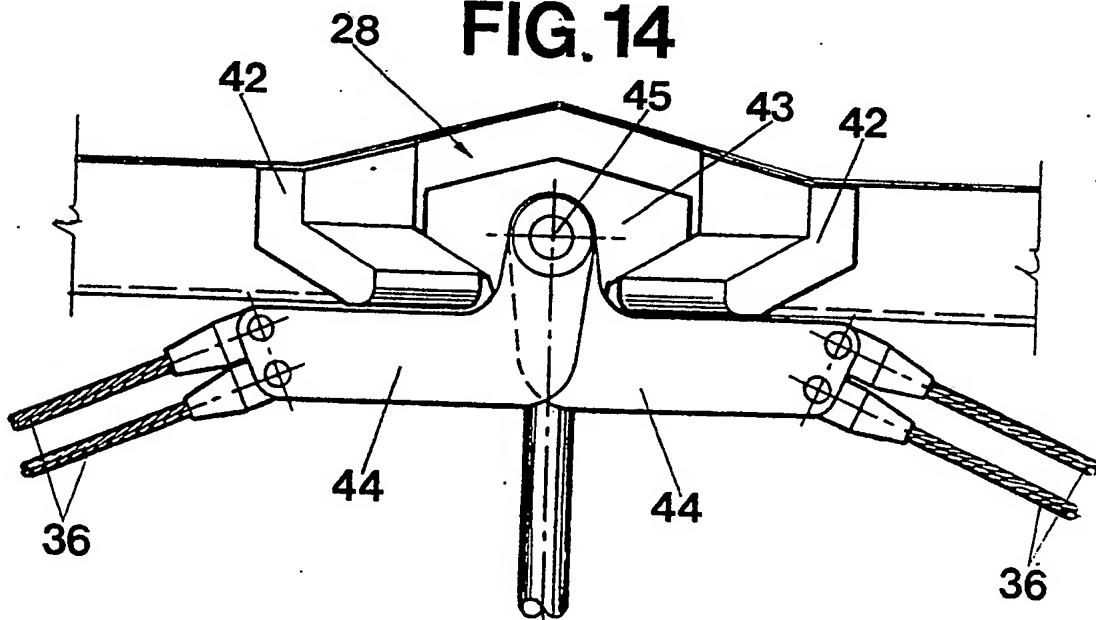


FIG. 14



INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 91/00232

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)⁶

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: B 63 B 21/00

II. FIELDS SEARCHED

Minimum Documentation Searched⁷

Classification System

Classification Symbols

IPC5:

B 63 B

Documentation Searched other than Minimum Documentation
to the Extent that such Documents are Included in Fields Searched⁸

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹

Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
A	GB, A, 2080228 (NAVIRE CARGO GEAR INTERNATIONAL AB.) 3 February 1982, see page 1, line 77 - line 93; figures 1,2 --	1,2,3,4, 5
A	US, A, 4697538 (DAY) 6 October 1987, see column 3, line 47 - column 4, line 16; figure 5 --	1,7
A	US, A, 4008678 (LAWLOR) 22 February 1977, see column 2, line 20 - line 46; figure 4d --	1
A	US, A, 4066030 (MILONE) 3 January 1978, see abstract; figure 1 --	1

* Special categories of cited documents:¹⁰

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IV. CERTIFICATION

Date of the Actual Completion of the International Search

12th June 1991

Date of Mailing of this International Search Report

1991 -06- 25

International Searching Authority

Signature of Authorized Officer

Christer Jönsson
Christer Jönsson

SWEDISH PATENT OFFICE

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
A	US, A, 3463114 (J. LOVELL) 26 August 1969, see figure 1 --	1
A	FI, A, 873245 (WÄRTSILÄ MERITEOLLISUUS OY) 25 January 1989, see abstract; figure 1 --	1
A	Patent Abstracts of Japan, Vol 6, No 76, M128, abstract of JP 57- 15093, publ 1982-01-26 (MITSUBISHI JUKOGYO K.K.) --	1
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
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